APPENDIX 1
TO ANNEX C TO DECISION SIXTEEN

AMPLITUDE FREQUENCY FUNCTION (AFF) COMPUTER-ASSISTED TECHNIQUE FOR CALCULATING THE MINIMUM HEIGHT ABOVE GROUND LEVEL AT WHICH EACH VIDEO CAMERA INSTALLED ON AN OBSERVATION AIRCRAFT MAY BE OPERATED DURING AN OBSERVATION FLIGHT AND PROCEDURES FOR VALIDATING THE AFF COMPUTER-ASSISTED TECHNIQUES

Pursuant to Decision 14, Section V, Paragraph 1 (A) (2) and Annex C to Decision 16, the following computer-assisted technique may be used.

SECTION I. PROCEDURES USED FOR THE DETERMINATION OF RESOLUTION OF THE VIDEO CAMERAS

After completion of paragraph 4, Section IV, Decision Number 14 the ground resolution for any configuration of video camera for the ith pass over the target is determined using a computer-assisted method in the following order:

1. From the test target image for each bar group a value of amplitude frequency function (AFF), designated by $A_i(f, H_i, K_i, \tau_i)$ shall be calculated, which represents the relationship of first harmonic amplitude in the target image from spatial frequency f=1/(2?), where ? is the width of the bar on the ground, or group number at given contrast on the target K_i, aircraft flight altitude H_i and the atmosphere characterized by transmission ? $_i$. To implement the procedure for the evaluation of the first harmonic amplitude an image or a mask of a given target should be used.

2. From separate readouts obtained in paragraph 1 above a smoothed AFF curve $A_i(f, H_i, K_i, \tau_i)$ is created.

3. A Threshold function (TF), designated by $M(f,P_{error})$, shall be calculated, which represents the relationship of the minimum value of the first harmonic amplitude, under which every target group will be resolved with a probability of error P_{error}, from a spatial frequency f. The TF is calculated on the basis of the evaluation of the correlation noise function of the video camera on the brightness fields of the target image, and its form depends on the target shape.

4. The resolution is determined from the spatial frequency given by the intersection of the AFF and TF curves.

SECTION II. PROCEDURE USED FOR CALCULATION OF H_{min}

1. The AFF $A_i(f, H_i, K_i, \tau_i)$ obtained for the ith pass above the target is recalculated to an agreed contrast K_a = 0.4. As a result of this step a new AFF $A_i(f, H_i, K_a, \tau_i)$ will be determined which corresponds to the aircraft flight altitude in the ith pass and for the agreed contrast.

2. On a basis of AFF calculated for the agreed contrast a family of AFF $\{A_{ik}(f, H_{ik}, K_a, \tau_{ak})\}$ is calculated, k = 1,2 3,..., at the agreed atmospheric conditions which are characterized by transmission t_{ak} for every altitude H_{ik}. The set of altitudes H_{ik}, for which the AFF is being recalculated, is selected in such a way as to include the intersection of AFF and TF at agreed resolution $?_{agreed}$ = 30 cm.

3. From the intersection points of the set of AFF, $A_{ik}(f, H_{ik}, K_a, \tau_{ak})$, and TF, $M(f,P_{error})$, a curve of aircraft flight altitude under agreed contrast and atmospheric parameters as a function of ground resolution H(?) of the video camera is prepared, which incorporates the value of agreed resolution, $?_{agreed}$ = 30 cm. From this curve a minimum altitude for a given pass shall be determined as:

$$H_{min\ i} = H(?_{agreed})$$

4. The procedures described in paragraphs 1 - 3 of Section II of this Appendix shall be repeated for n passes when analyzing the image of a test target; $n \geq 5$ in case of certification and $n \geq 1$ in case of demonstration flights. As a result, a set of minimum altitudes $\{H_{min\ ij}\}$ will be obtained, where i is the number of a pass above the target and j = 1 for a target set across the aircraft track, and j = 2 for a target set along the aircraft track.

5. $H_{min\ ij}$ value is used to calculate average values $H_{min\ j}$ from the resolution evaluation across and along the aircraft track:

$$H_{min\ j} = \frac{1}{n}\sum_{i=1}^{n} H_{min\ ij}$$

6. The minimum permissible altitude H_{min} value for a given configuration of video camera is the largest of the values of minimum permissible altitudes H_{min1} and H_{min2}, obtained for a set of targets located along and across the aircraft track.

SECTION III. PROCEDURE FOR VALIDATION OF A COMPUTER- ASSISTED CALCULATION OF H_{min}

1. Software validation is conducted in two stages using the test pattern 4 from Annex A of Decision Number 16. During the first stage calculation of the resolution is evaluated, during the second stage the accuracy of the H_{min} calculation is evaluated. Calibration input data given in Table 1 is entered for that purpose into the H_{min} calculation software.

2. Calculation of the resolution is validated as follows:

(a) In accordance with paragraph 1, Section I of this Annex, an amplitude frequency function $A_i(f, H_i, K_i, \tau_i)$ is plotted from the test pattern 4 image;

(b) Noise characteristics of the equipment are measured along the noise field of test pattern 4, which should match the values provided in Table 2.

3. In accordance with paragraph 2, Section I of this Appendix, the threshold function $M(f,P_{error})$ is plotted. The intersection of $M(f,P_{error})$ with the amplitude frequency function determines the resolved bar group, which must correspond to 11 for the AFF computer-assisted technique to be validated.

4. The accuracy of the H_{min} calculation is determined from the software output, which for the provided input data and the resulting H_{min} must be in the range of 830 to 870 meters for the AFF computer-assisted technique to be validated.

Table 1

No.	Parameter	Calibration value
1	Width of a single bar in the first bar group	0.6 m
2	Length of bars in the first bar group	3 m
3	Bar widths reduction coefficient	0.890899
4	Meteorological visibility (MV)	10,000 m
5	Average reflectance of a dark bar	0.4
6	Average reflectance of a light bar	0.5
7	Ground illumination	80,000 Lx
8	Equipment focal lengths	30 cm
9	Linear dimensions of radiation detector	12 μm
10	Aircraft flight altitude	400 m
11	Agreed value of MV	10,000 m
12	Agreed value of reflectance of a dark bar	0.2
13	Agreed value of reflectance of a light bar	0.6
14	Agreed value of resolution	0.3 m
15	Probability of error	0.2

Table 2

No.	Parameter	Calibration value
1	Average value of equipment noise	62 ... 65
2	Standard deviation value of equipment noise	1.0 ...1.5
3	Correlation radius of equipment noise values	2 ... 3